

1.1 User Display Monitor and Plotting Overview

The *User Display Monitor and Processing* thread supports monitor-only user display application development and processing on the Checkout and Launch Control System (CLCS) Human Computer Interface (HCI) Workstation. It also provides a path-finding demonstration of extensions to the selected dynamic data visualization tools (DDVT) to support advanced data plotting features such as those provided by a PCGOAL Workstation.

1.2 User Display Monitor and Plotting Concept

The User Displays to be supported during Redstone will provide passive observation of data through a number of display tools. Top-level displays will be built using a DDVT. These displays will represent information in a graphic format. Additional information about specific components on the graphics display will be provided to the user with *viewers*. Each viewer receives data through the Applications Services and User Display Services interfaces (API), which provide a defining layer between the viewers, displays and the underlying data distribution mechanism. Viewers will display data in textual representations.

An added feature of the User Displays will be the ability to plot data. Current plotting goals include the ability to display the progress and change of up to six variables over time. The plotting option will be a menu choice for a given item as a result of clicking on the graphical representation of the item.

Plotting capabilities anticipated in this thread will provide various powerful options. Fundamental plotting of multiple entities against a common axis, such as time, and the ability to scroll forward and backward along the plot are key features.

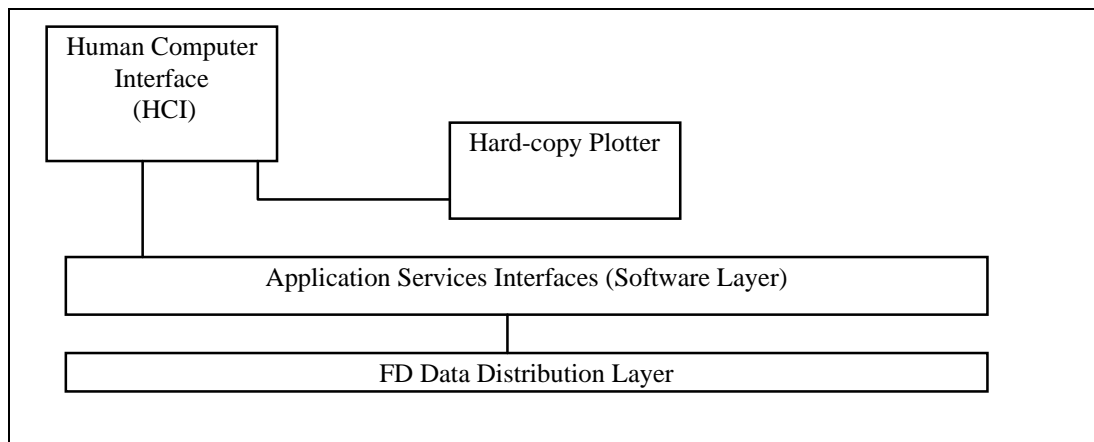


Figure 1: User Display and Plotting Support Layout

1.3 User Display Monitor and Plotting Specification

The User Display Monitor and Plotting Thread is expected to accomplish the following work in the Redstone time frame (the following lists are re-prints of the Statement of Work for Redstone; derived requirements are given at the end.):

User Display Monitor:

- Validate feasibility of current choice of SL for user display tool. If SL is not tool, provide trade study of COTS and custom solutions.
- Provide a strategy for use of display tool.
- Provide the foundation building blocks for display development by users.
- Provide at least one screen for selected Responsible System (RSYS) (with support from the RSYS Engineer) on the selected tool as a user display pathfinder.
 - a) Provide a user evaluation report of selected display tool.
 - b) Document manpower to train and build displays.
 - c) Update the Work Breakdown Structure (WBS) Basis Of Estimate (BOE).
- Provide upgrades to perform the following for each data point:
 - d) Interface and selection for plotting.
 - e) Interface display tool to Function Designator (FD) Status Information display.
 - f) Interface to System Viewers (Interface only).
- Provide interface to FD CLCS data and health.
- Provide performance data for display startup time, values displayed per second, and CPU utilization.
- (Derived): Provide a capability to deliver the software to the LCC-X environment in a controlled manner.

Plotting Pathfinder:

1. Evaluate various plot services, both COTS and custom.
2. Provide real-time plotting of up to a minimum of 6 concurrent measurements on the same scale (for example, 2 measurements for each of 3 engines).
3. Provide for time scales zoom or zoom out under mouse control from 8 hours to 10ms
4. Provide an interface that allows FDs to select by cursor on user displays to be plotted.
5. Provide for adjustment of gain scale under mouse control.
6. Provide forward and backward movement in time.
7. Provide for display of both countdown and GMT time.
8. Provide support for Ground Support Equipment (GSE) Analog, GSE Discrete, and Super Lightweight Tank (SLWT) FDs.
9. Integrate plotting function with the CLCS data streams.
10. Provide a demonstration and a user evaluation.
11. Provide performance data for display startup time, CPU utilization and plotting performance data.
12. Provide a hard-copy capability.

1.4 User Display Monitor and Plotting Assessment Summary

Code for the User Display Monitor thread will be developed by applications developers to support the Super Lightweight Tank demonstration for Redstone. Scope of the number of displays to be developed for Redstone is given in the table in Section 1.5.

The following are responses to the Statement of Work for Redstone.

User Display Monitor:

- *Validate feasibility of current choice of SL for user display tool. If SL is not tool, provide trade study of COTS and custom solutions.*

(Validation activity is nearly complete. Training in SL-GMS was recently concluded. Prototype libraries are being built and populated with pertinent objects.)

- *Provide a strategy for use of display tool.*

(The implementation approach for building System Viewers consists of several steps:

1. Begin with a list of current Launch Processing System (LPS) displays, and select the path-finding set that will achieve the concept demonstration in the Redstone time frame. This set will be targeted toward monitoring of the SLWT.
2. Using the list gathered from above, determine whether the display should be retained for CLCS, or if it has exceeded its useful life.
3. Based on the selected set of displays, build the object components needed to implement the displays in the CLCS architecture. The components should be considered the “foundation building blocks”, and as many as possible will be retained.
4. Build interfaces to the Data Handler for SL-GMS.
5. Build interfaces, as needed, to Application Services API.)

- *Provide the foundation building blocks for display development by users.*

(The objects generated for SL-GMS displays will become the foundation objects for future user display work. The Monitors and Viewers generated will demonstrate the ability to communicate data about FD information from the displays.)

- *Provide at least one screen for selected Responsible System (RSYS) (with support from the RSYS Engineer) on the selected tool as a user display pathfinder.*

(This will be satisfied using the Super Lightweight Tank (SLWT) Monitor as a Pathfinder/prototype. BOE Measurements will also be reported in that thread.)

1. Provide a user evaluation report of the selected display tool.
2. Document effort to train and build displays.
3. Update the Work Breakdown Structure (WBS) Basis Of Estimate (BOE).

- *Provide upgrades to perform the following for each data point:*

(A number of options are available in the “buy/modify” capability. This will aid in re-use, raising reliability and lowering ultimate maintainability cost through the use of code with “shelf life”.)

4. Interface and selection for plotting.
5. Interface display tool to Function Designator (FD) Status Information display.

6. Interface to System Viewers (Interface only).

- *Provide interface to FD CLCS data and health.*

(This interface will be satisfied through the Application Services API.)

- *Provide performance data for display startup time, values displayed per second, and CPU utilization.*

(SL-GMS provides tools that show the performance of the product. Most Unix platforms already have CPU utilization tools. Any additional performance tools that may be useful from the MCC code will also be ported.)

Plotting Pathfinder:

- *Evaluate various plot services, both COTS and custom.*

(The plot evaluation has begun, starting with SL-GMS. LMSMS has also upgraded its plotting capability per suggestions from last year's Mission Planning and Support Room (MPSR) exercise at Kennedy. These options appear to satisfy most, if not all, of the requirements described in the previous section, so no additional comments will be provided here.)

Summary of CSCI Assessment for User Display and Plotting Thread

<i>Number</i>	<i>CSCI Name</i>	<i>EP (Redstone)</i>	<i>Comments</i>
1	System Viewer CSCI	3	Assessment presumes acceptance of SL-GMS as the DDVT; reuse of System Advisory from MCC for System Message Viewer (with necessary extensions); use of either SL-GMS or MCC's Plot Widget for plotting pathfinder
2	Application Services CSC I	5	Assessment presumes acceptance of SL-GMS as the DDVT; reuse of Application Services APIs from MCC

1.5 User Display Monitor and Plotting Deliverables

The User Display Monitor and Plotting Thread consists of the following deliverables for Redstone:

<i>Product</i>	<i>Quantity</i>	<i>Estimated Size</i>	<i>Comments</i>
FD Viewers and Monitors	4	2500 SLOC	DD requires FD Viewer, FD Monitor, Data Fusion Viewer, Data Health Viewer
X/Motif Plot Widget	1	10 KSLOC	Ported from MCC
Pathfinder SLWT Display Monitor	1	SL-GMS Specific	SLWT requires FD Viewer, which will be configurable (FD Fusion, Status, Health)
System Message Viewer	1	400 SLOC	The primary display will be ported from MCC. The estimate includes accounting for additional, KSC specific features.

1.6 User Display Monitor and Plotting Schedule

<i>Phase</i>	<i>Start Date</i>	<i>End Date</i>
Panel One (Requirements Definition)	2/20/97	3/28/97
Developer Orientation	3/31/97	5/9/97
Panel Two (Preliminary Design)	3/31/97	5/9/97
Panel Three (Detailed Design)	5/12/97	5/30/97
Coding	6/2/97	6/27/97
Unit Test	6/30/97	8/8/97
Integration Test	8/11/97	8/22/97
System Integration and Acceptance Test	8/25/97	9/26/97

1.7 User Display Monitor and Plotting Simulation Requirements

The User Display Monitor and Plotting thread shall require the flow of data to exercise the functions. Data flow may be provided through a Shuttle Data Stream, or a recorded data stream. Operational data will be provided to the thread through the Application Services CSCI, which shall provide an interface to the Data Distribution layers of the system.

1.8 User Display Monitor and Plotting System Test Requirements

System Testing for the User Display and Monitor and Plotting Thread will require the hardware described below, the CSCIs identified in section 1.5 and 2.0, and connection to a viable source of data, as described in Simulation Requirements above.

The System Test Organization has not yet established specific test cases for this thread.

1.9 User Display Monitor and Plotting Training Requirements

Training will be required at the following levels:

- *Developer/Sustaining Engineer training* - each developer will require three weeks to become familiar with the SL-GMS tool set, and three weeks to become familiar with the Requirements, design, and methodologies of the implementation
- *Operations Personnel training* - Two days will be required for operations personnel to become familiar with the products of this thread. This includes a half-day of direct tutorial, a half-day of simulation usage of the products, and a day to access the on-line documentation concerning the products.

1.10 User Display Monitor and Plotting Facilities Requirement

The User Display Monitor and Plotting Thread presumes the presence of the following minimal configuration:

1. One instance of the HCI environment running IRIX 6.3, such as a Silicon Graphics (SGI) model *O2* or model *Indy*
2. A license on the HCI machine for SL-GMS
3. Space will be required in the LCC-X for a hardcopy plotting device to assure that the printing capability of the selected plotting tool is functional and correct.

1.11 User Display Monitor and Plotting Procurement

Where possible, the User Display Monitor and Plotting thread will re-use code products and tools from the MCC delivery. Such possibilities include the X/Motif Plot Widget and the Advisory Services user interface (GUI).

These tools should be made available by May 1 to allow integration and familiarization. Written products for these tools should be made available to developers by April 15.

1.12 User Display Monitor and Plotting Dependencies

<i>Number</i>	<i>CSCI/HWCI Name</i>	<i>Need Date</i>
1	Manuals for MCC tools made available to users	4/15/97
2	System Advisory Services and Plot Widget available for checkout	5/1/97
3	Application Services CSCI	7/1/97
4	Data Distribution CSCI	8/12/97

1.13 User Display Monitor and Plotting Action Items/Resolution

Assessment Actions to be resolved:

<i>Assignee</i>	<i>Action</i>	<i>Resolution</i>	<i>Target</i>
Payne	Determine User Display Development standards		5/2/97
Payne	Gather data from Bill Lembke on Human Factors engineering of color choices on displays		5/2/97
Payne	Elaborate on the performance data gathering of the specific use of the tools, not on performance tools for the long run	See the description in section 1.4. SL-GMS provides a number of tools to measure display performance.	3/25/97
Payne	Gather assessment on the effectiveness of SL-GMS		3/28/97
Payne	Review with MCC sources the impact of NT needs on selection of X/Motif based tools and widgets		5/2/97
Payne	Talk to Tom Beever about specific hard-copy plotting requirements	Preliminary conversations held. Tom will provide more details.	3/25/97
Payne	Determine scope of inputs for "plotting history" and impacts on SDC requirements		5/2/97
Payne	Move metrics bullets to SLWT thread	See the SLWT thread.	3/26/97

2. CI Assessments

2.1 System Viewer CSCI Assessment

The System Viewer Computer Software Configuration Item (CSCI) will provide support to the User Display and Monitor thread through the use of modular, object-oriented display components called *viewers*. Specifics about viewer implementation will be addressed in the Design Panel 2 level documents. It is intended that displays have a common, universal “look and feel”, which will stem from the re-use of display components in building a viewer.

Support for the User Display Monitor and Plotting Thread will be provided in the *System Viewer* CSCI in the form of several displays:

1. *FD Viewer* - this set of displays will be used in testing of data distribution and communication with the
2. *FD Monitor* - this set of displays will be used in testing of data distribution
3. *Data Fusion Viewer* - this set of displays will be used in end-to-end testing of data distribution
4. *Data Health Viewer* - this set of displays will monitor the health and status of data distributed
5. *System Advisory Viewer* - this tool is needed for both debugging and for sending informational/advisory messages concerning the system to the Human Computer Interface (HCI)

FD Viewer Work Required

1. The FD Viewer shall provide a window to display Function Designators (FDs) on the HCI.
2. The FD Viewer shall provide the ability to examine details underlying an FD's value.
3. The FD Viewer shall provide a color designation indicating connectivity or activity of the data viewed.
4. The FD Viewer shall provide the user the means to exit the display and close out data display requests.

FD Monitor Work Required

1. The FD Monitor shall provide a window to display events related to FDs on the HCI.
2. The FD Monitor shall provide the ability to monitor exceptions concerning an FD.
3. The FD Monitor shall cyclically update FDs and related data chosen for display.
4. The FD Monitor shall provide the user the means to exit the display and close out exception display requests.

Data Fusion Viewer Work Required

1. The Data Fusion Viewer shall provide a window to display the components of an FD on the HCI.
2. The Data Fusion Viewer shall determine low-level and high-level end-item state.
3. The Data Fusion Viewer shall provide the ability to test composite FD values directly.
4. The Data Fusion Viewer shall provide a data smoothing function to extrapolate meaningful signals from the data stream.
5. The Data Fusion Viewer shall provide the ability to map FD values and data health into end-item actual states.
6. The Data Fusion Viewer shall provide the user the means to exit the display and close out data display requests.

Data Health Viewer Work Required

1. The Data Health Viewer shall provide a window to display Data Health (FDs) on the HCI.
2. The Data Health Viewer shall provide the ability to examine details underlying an FD's value.
3. The Data Health Viewer shall cyclically update FDs and related data chosen for display.
4. The Data Health Viewer shall provide a color designation indicating connectivity or activity of the data viewed.
5. The Data Health Viewer shall provide the user the means to exit the display and close out data display requests.

System Advisory Viewer Work Required

1. The System Advisory Viewer shall provide a graphical user interface (GUI) to status the health of the Data Distribution subsystem.
2. The System Advisory Viewer shall classify message severity as defined in the System Advisory CSC.
3. The System Advisory Viewer shall time-tag all messages displayed.
4. The System Advisory Viewer shall provide the capability to acknowledge messages, and shall change the background to indicate that messages have been acknowledged.
5. The System Advisory Viewer shall provide the capability to print accumulated advisories.

CSCI Assessment

<i>Function Name</i>	<i>CSCI Labor (EP)</i>	<i>% of CSCI</i>	<i>Estimated Lines of Code (Redstone)</i>
FD Viewer	2	20%	600
FD Monitor	1	10%	300
Data Health Viewer	2	20%	600
Data Fusion Viewer	4	40%	1200
System Message Viewer	1	10%	400

Documentation

Descriptions for the viewers will be provided as part of the Checkout and Launch Control system (CLCS) Web. Each page will provide an example of a viewer, a description of how the features of the viewer are involved, and a description of the start-up sequence for the viewer.

The System Message Viewer will be described by the currently published User's Guide (NOTE: this is applicable for the MCC tools or code that is reused). Additions to the current display will be documented on-line, using the "help" feature provided on the display.

Assumptions

An alternative for implementation that may mitigate code estimates for the System Message Viewer is the MCC tool *Advisory Services*. In its current form it meets many of the requirements for the System Message Viewer.

Plotting options that may provide a "buy" or "modify" alternative are being assessed. The plotting capabilities of SL-GMS are under evaluation by users. The MCC Plot Widget also meets much of the proposed capability, and is an enhancement to the Strip Chart Recorder that was evaluated at Kennedy in early 1996.

Additional options and opportunities for reuse from the MCC tools will be explored during the design phase of the System Viewer CSCI.

Open Issues

Resolution of data viewing across multiple Test Control Identifier (TCIDS) is not yet addressed. This includes the layout, selection, and identification of FD Data stemming from multiple TCIDS.

Training for new display developers cannot be correctly extrapolated from building of a single display. Using a number of displays of varying graphical complexity and FD density would give better data on developmental costs.

2.2 Applications Services CSCI

Interfaces to the data distribution layer of CLCS will be provided through the Application Services CSCI. The CSCI will provide services to access data, health, and fusion algorithms for requested FDs.

Constraint Management Services Work Required

The Constraint Management services will not be used in Redstone.

FD Services Work Required

1. FD Services shall provide measurement and stimulus data.
2. FD Services shall provide a set of APIs allowing applications to test measurement FDs.
3. FD Services shall provide both raw and processed data from data distribution to the User Displays and the plotting function.

On-Line Data Bank Services Work Required

1. OLDB Services shall provide access to OLDB-generated intra-node data products.
2. OLDB Services shall provide a validation control to assure that requesting User Displays are authorized to receive the data.

User Display Services Work Required

1. User Display Services shall provide the capability for User applications to communicate with User Displays.
2. User Display Services shall connect an FD-related display widget to the corresponding display value without the need for a callback.
3. User Display Services shall provide an interface for SL-GMS based User Displays to access objects (FD data, functions).
4. User Display Services shall provide an interface for SL-GMS based User Displays to access X/Motif pop-up text entry displays.
5. User Display Services shall provide an interface for SL-GMS based User Displays to access X/Motif pop-up displays for output of data.

CSCI Assessment

<i>Function Name</i>	<i>CSCI Labor (EP)</i>	<i>% of CSCI</i>	<i>Estimated Lines of Code</i>
FD Services CSC	2		3,000
On-Line Data Bank CSC	1		3,000
User Display Services CSC	2		5,000

Documentation

The Applications Services CSCI will be documented on-line with “man” pages, which will be placed on the Unix platforms developing with the services, and off-line with an API manual. An “as-built” design specification will be provided for services that are reused from MCC. A User’s Handbook, test products will also be provided.

Assumptions

The Applications Services CSCI assumes that OLDB products use the same format on all software-running components of CLCS (DDP, CCP, HCI). Actual OLDB products will be required two weeks prior to code complete for the CSCI. The interface to the OLDB products will be through User Display Services.

The CSCI will be programmed in C and C++ at the discretion of the development team.

Open Issues

Several issues concerning this CSCI are specific to Redstone. No checking or validating that the reader or writer has permission to perform the function will be done. Read-only access will be provided to the OLDB.

3. COTS Products Dependencies

3.1 SW Products Dependency List

- *SL-GMS* - Graphical object-oriented development tool used for fast prototyping and building of displays
- *MSC X/Motif Plot Widget* - Compact Motif object that provides much of the plotting capability identified in the Pathfinder requirements

3.2 HW Products Dependency List

The User Display Monitor and Plotting Thread requires that the HCI has a bit-mapped and windowing display capability, such as a Silicon Graphics (SGI) model *O2* or *Indy*, and that a plotting printer be connected. As an alternative to a plotting printer, it may be possible to spool the plot to a file and use a laser printer. See Section 1.10.